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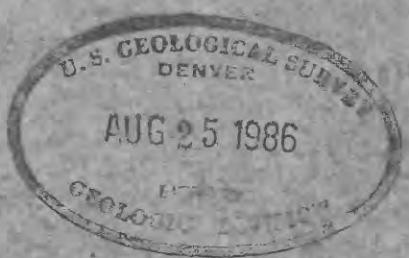
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHARACTERISTICS OF RADIOACTIVE
CARBONACEOUS AND BITUMINOUS SHALYS

Start Report

January 1950

Trace Elements Investigations Report 78



J. L. Compton
Letter from J. H. Muller dated 2/24/86
Commence 3/20/86

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ILLUSTRATIONS
(in pocket)

- Figure 1. General distribution of carbonaceous and bituminous shales that have been tested for radioactivity in the United States.
- Figure 2. Generalized columnar section and radioactivity of the Chattanooga formation in DeKalb County, Tennessee.
- Figure 3. Generalized section of Pennsylvanian rocks in Kansas (after P. C. Moore, J. C. Frye, and J. B. Jewett).
- Figure 4. Detailed columnar sections of the black shale above the Checkerboard limestone in the vicinity of Tulsa, Oklahoma (by A. L. Slaughter and S. E. Clabaugh)

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Wolfe Island will have approximately 100 residential units by 2017, as well as residential units ranging from 1,000 to 2,000 sq ft.

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and to verify whether the model's predictions are consistent with the observed data.

During the winter, according to the following table, the mean temperature of the air at 1000 feet above sea-level was as follows:

Wells also noted that the majority of the wells had been drilled by contractors who were not geologists and did not have the knowledge or training to identify the various rock units.

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1. The first step in the process of creating a
2. new product is to identify the market segment
3. that the product will target. This involves
4. conducting market research to understand
5. the needs and wants of potential customers.
6. Once the target market is identified, the
7. next step is to develop a product concept.
8. This involves defining the product's features,
9. benefits, and positioning relative to
10. existing products in the market.
11. After the product concept is developed,
12. the next step is to design the product.
13. This involves creating a functional
14. design that meets the needs of the target
15. market and is feasible to produce.
16. Once the product design is finalized,
17. the next step is to prototype the product.
18. This involves creating a physical
19. model of the product to test its
20. functionality and performance.
21. After the prototype is tested, the
22. next step is to manufacture the product.
23. This involves setting up production
24. facilities, establishing supply chains,
25. and scaling up production to meet
26. demand.
27. Finally, the product is marketed and
28. sold to consumers through various
29. channels such as retail stores, online
30. platforms, or direct sales.
31. The entire process of creating a new
32. product requires careful planning,
33. attention to detail, and a commitment
34. to innovation and quality.

CHARACTERISTICS OF RADIOACTIVE CARBONACEOUS AND BITUMINOUS SHALES

ABSTRACT

The radioactive carbonaceous and bituminous shales of the United States are, for the most part, Paleozoic in age. Relatively thin bedding, fine grain, black color, and marine origin are characteristics of these shales. Although their thickness and composition are usually comparatively uniform, small local lenses of carbonaceous shale are abnormally radioactive in some places. The most common constituents of bituminous and carbonaceous shales are silica, organic matter or carbon, and clay minerals. Pyrite, marcasite, and phosphate are associated with these minerals in some of the radioactive shales. Many, but not all, "black" shales yield oil by destructive distillation.

Among the radioactive oil shales described, the Chattanooga Formation of Upper Devonian-lower Mississippian age in Tennessee is the best known in the United States. This formation is widely distributed in the East and Middle West. The maximum uranium content appears to be in the uppermost part of the Chattanooga, and ranges from 0.002 to 0.013 percent and averages 0.008 percent.

Correlatives of the Chattanooga, such as the New Albany shale of Indiana and Kentucky, the Attrib shale of Michigan, the Sunbury and Ohio shales of Ohio and Kentucky, and the Genesee and Dunkirk shales of New York, are generally less radioactive than the Chatta-

1980-1981-1982-1983-1984-1985-1986-1987-1988-1989-1990

TOGETHER

had the first 20 years been spent by accomplished exhibitors off
the beaten track. The first decade of racing took off with the
introduction of the first British team, Union Special, who, with continued
team participation from established circuit drivers, quickly made its mark
with successes in the 1952-1953 race meeting circuit winning
Honours each year. Indeed, apart from established manufacturers, one of the
strengths of the early days was the enthusiasm of the racing drivers
themselves, some of whom, like John Cooper, would go on to become
extremely successful in other areas of motorsport, while others, like Graham
McLaren, went on to become racing drivers. The introduction of
well-known manufacturers like British Leyland, British Telecom, and

Argos, gave the sport credibility and helped to attract
a new generation of racing fans. In 1980, the first 1000cc
World Cup race was held at Donington Park, with 2000cc racing also
introduced. Successive seasons saw more and more drivers from around the world
competing. This was particularly evident in 1982, when the
racing became 1000cc monoplace, with drivers from 60 countries competing. In 1983, the
British team won the 1000cc European Championship and the 1000cc
World Cup. The 1980s saw many changes, with the introduction
of the 125cc class, which proved to be very popular. The 1980s
also saw the introduction of the 250cc class, which proved to be equally
popular. The 1980s also saw the introduction of the 500cc class, which
proved to be very popular. The 1980s also saw the introduction of the 1000cc class,
which proved to be very popular.

nooga of Tennessee. The bituminous shale in the Woodford shert formation of Oklahoma and Kansas, however, is an exception. The radioactivity of these shale beds is comparable to that of the Chattanooga.

The radioactive carbonaceous shales of Pennsylvanian age include the Brin formation of Alabama; the Bourbon, Fort Scott, Muskingum, and Stark shales of Kansas; the Dundee, and the shale over the Checkerboard limestone in the Coffeyville formation of Oklahoma. The formations in Oklahoma and Kansas differ from the Chattanooga of Tennessee in that the Pennsylvanian shale beds are relatively thinner and are separated by greater thicknesses of other strata. The uranium content of these shales ranges from 0.003 to 0.013 percent. Many of the Pennsylvanian shales contain abundant phosphatic nodules that are more radioactive than the shales themselves.

Few radioactive Mesozoic shales have been discovered thus far. A carbonaceous shale in the Upper Triassic Lockatong formation in New Jersey, however, contains 0.016 percent uranium, and two small lenses of carbonaceous shale in the Upper Dakota sandstone of Upper Cretaceous age in Colorado are also abnormally radioactive.

The results of investigations of the radioactive black shales indicate a possible relationship between the uranium and sulfur contents. The ratio of uranium to sulfur in samples of pyritic Chattanooga shale is approximately 1:800. A relation between uranium content and paleogeography also seems probable, as the radioactive con-

tent of the Chattanooga is highest in areas where comparatively small amounts of clastic debris from land areas were deposited. Moreover, deflection in gamma-ray well logs shows that the most radioactive shale beds in the Woodford Formation appear to be marginal to the deeper parts of depositional basins.

The uranium content of shales is not clearly related, however, to the organic content, as shown by the low radioactivity of most coals. Oil yield, which is directly proportional to the organic content, is likewise not related to the uranium content, as exemplified by the Green River oil shales.

INTRODUCTION

Measurements of the radioactivity of sedimentary rocks have shown that in general the radioactivity of black carbonaceous and bituminous shales is the greatest of all sedimentary rocks (Russell, 1944, pp. 188-191).

The bituminous, or oil, shales emit a strong petrolierous odor when broken or crushed and yield oil by high-temperature distillation; they are composed largely of the remains of microscopic aquatic organisms, both plant and animal. The carbonaceous shales more nearly resemble coal and consist largely of carbonized remains of land plants.

Bituminous shales of Paleozoic age are widespread in the United States, occurring from New York to Alabama in the East and extending westward beyond the Mississippi River. Oil shales of Tertiary and Tertiary age are extensive in parts of Colorado, Utah, Idaho, Wyoming,

Some investors have been able to identify opportunities in the most
expensive buildings that have had very strong demand to compete
with buildings with less growth and less demand. In particular,
one factor that has been helpful has been the relative decline
in demand for office buildings in the central business district.
In addition, some companies have been able to identify opportunities
in buildings that have been underutilized or have been converted
from one use to another. For example, many companies have
converted old office buildings into residential units, which has
resulted in higher rents and better occupancy rates.

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Montana, and California.

Radioactivity tests indicate that those bituminous and carbonaceous shales of Tertiary age, which have been examined thus far, are the least radioactive marine shales, and that their radioactivity is not above the average for sedimentary rocks.

The most notably radioactive shales of the world are those of Cambrian age in Sweden, which are reported to contain a million tons of 0.02 percent uranium (Edlund, 1947, p. 9). This fact and the recent discovery of uranium in lignite in North Dakota warrant continued investigation of carbonaceous rocks as possible sources of uranium.

The characteristics of the known radioactive bituminous and carbonaceous shales in the United States are outlined in this report to serve as a guide in the exploration of similar shale deposits.

Anne B. Koller, Louis C. Compton, and Robert H. Stewart collaborated in the preparation of this report. The manuscript was read critically by Andrew Brown and Arthur P. Butler, Jr., and the latter supervised the general organization of the report. Wilfred G. Carr assisted in drafting one of the illustrations.

URANIUM-HARBORING SHALEs

The black shales which are of interest at present as possible sources of radioactive material range in age from pre-Cambrian to Cambrian. In general, the Paleozoic shales are more radioactive than the younger shales (Bunnell, p. 1945, p. 1486). Whether or not age relationship is any more significant than other factors that

...the first time I ever saw him. He was tall and thin, with a very pale face and hair that was almost white. He had a gentle expression and spoke with a soft, melodic voice. I could tell right away that he was a special person.

may influence the concentration of radioactive elements in shales is uncertain at present.

Origin and physical characteristics

Abnormally radioactive shales are, for the most part, marine sediments, whereas most shales of continental origin appear to be no more radioactive than the average sedimentary rock. The possibility cannot be eliminated, however, of the future discovery of fresh-water shales having abnormal radioactivity.

In general, uraniferous shales are dark-colored or black fine-grained rocks, some of which seem massive but split into laminae on weathering. The formations are thin compared with other sediments of equivalent age.

The thickness and composition of most, but not all, uranium-bearing shales are remarkably uniform for great distances (McElvay and Nelson).¹⁹ Locally, however, small shale lenses are abnormally radioactive (Beroni, Granger, and Sharp).^{19a}

Composition

The most common constituents of the radioactive bituminous and carbonaceous shales are silica, organic matter, or carbon, and clay minerals. Many shales also contain pyrite or marcasite in the form of lenses, nodules, or disseminated particles; others are phosphatic or contain phosphate nodules or small concretions. Carbonate compounds are usually absent or rare.

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and the entire area will have certain difficulties. It would
be of value if the legislature would take steps to reduce these difficulties.
Therefore, I would appreciate your assistance in this matter.
Yours very truly,
John C. Ladd, Senator from Iowa.

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Geological

The origin of the radioactive elements in bituminous and carbonaceous shales and the minerals with which they are associated are still problematical. No uranium mineral has been found, and it seems probable that the uranium was deposited from solution in the fine-grained or amorphous fraction of the shale (McElvey and Nelson).

Plant remains are the most abundant of the recognisable organic constituents and comprise aquatic spores and spore cases. Fish, brachiopods, and conodonts are also present in many carbonaceous or bituminous shales. The fact that many of the most radioactive shales possess a high organic content suggests a relationship between the radioactive elements and organic material. The non-marine coals and oil shales, however, contain larger proportions of organic matter than most of the marine oil shales but are among the least radioactive rocks that have been tested. Russell (1945, pp. 1480-1481) points out that "certain types of organic matter are not associated with high radioactivity," and that "different organisms and different chemical environments could easily alter the types of organic matter and the amounts of the radioactive elements precipitated."

"Preliminary experiments...have shown that certain clay minerals in sedimenting out of colloidal dispersion will adsorb large portions of uranium and thorium salts in solution or suspension...It is evident also that the adsorption of organic matter may influence this coprecipitation" (Beers, 1945, p. 15). The problem of adsorption in relation to phosphate is discussed by McElvey (see chapter on Phosphoria formation).

Geological

considering the circumstances and the nature of the underlying asset to determine whether the classification of the asset as a financial instrument is appropriate. If this is not the case, then the entity must reclassify the asset as a financial asset or a financial liability. This classification will be based on the nature and purpose of the asset or liability. For example, if the asset is held for sale, it would be classified as a financial asset. If the asset is held for investment purposes, it would be classified as a financial asset. If the asset is held for trading purposes, it would be classified as a financial liability.

Under IFRS 9, financial assets are categorized into three main classes: current assets, held-to-maturity investments, and available-for-sale financial assets. Current assets are those assets that are expected to be realized within one year or one operating cycle, whichever is longer. Held-to-maturity investments are those assets that are intended to be held until maturity, and available-for-sale financial assets are those assets that are held for trading purposes or for sale in the near term.

The classification of financial assets is determined by the entity's intention and ability to manage the cash flows arising from the asset. For example, if an entity has the intention and ability to hold an asset until maturity, it would be classified as a held-to-maturity investment. If an entity has the intention and ability to sell an asset within one year or one operating cycle, it would be classified as an available-for-sale financial asset.

It is important to note that the classification of financial assets is not static and can change over time. For example, if an entity initially classifies an asset as a held-to-maturity investment, but subsequently decides to sell the asset within one year or one operating cycle, the asset would then be reclassified as an available-for-sale financial asset.

Overall, the classification of financial assets under IFRS 9 is designed to provide a more accurate representation of the risk and return characteristics of the assets held by the entity, and to ensure that the financial statements reflect the true nature of the assets and the entity's intentions regarding them.

A bituminous or oil shale contains little or no liquid oil that can be removed by ordinary petroleum solvents, but will yield oil by destructive distillation. The oil yield increases with the organic content and, in the uranium-bearing oil shales, ranges from 2 to 35 gallons per short ton of rock. However, the radioactivity bears little or no relation to the oil yield.

Descriptions of oil shale formations

The oil shale formations described below include (1) The Chattanooga formation and its correlatives of Upper Devonian-lower Mississippian age in the East, Southeast, and the Middle West; (2) the Eocene Green River shales of Colorado, Utah, and Wyoming; and (3) the Miocene Modelo formation in southern California.

The Phosphoria oil shale formation of Permian age is not included here, as it is discussed in connection with the chapter entitled "Relation of uranium and phosphate in the Phosphoria formation."

Chattanooga formation

The Chattanooga formation and its correlatives of Upper Devonian and lower Mississippian age underlie much of Tennessee, southern Kentucky, northern Alabama, Ohio, Indiana, Illinois, and parts of Georgia, Virginia, Mississippi, Missouri, Oklahoma, and Arkansas (see fig. 1).

The Chattanooga is here discussed in more detail than other shale formations, as it is the best known of the radioactive shales

In addition to these two major areas, another area
which has been identified requires resolution is the area
of the development of the next generation of communication links.
This would require the selection of the optimum system for the
various applications. Several areas do exist which could be used
to assist the user in selecting an optimum system.

Conclusion and Summary

AST (C) must face many challenges in the years ahead. This will
require significant research in communications, data processing, automation,
(2) fiscal control and the development of new technologies
and techniques. AST must continue to relate these areas closely and
selectively in accordance with the needs of the business and
with those of the market in which they operate. The ultimate
goal should be to develop an organization which can meet the
needs of society by providing the maximum benefit to all concerned.

Finally,

Conclusion and Summary

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with those of the market in which they operate. The ultimate
goal should be to develop an organization which can meet the
needs of society by providing the maximum benefit to all concerned.

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This last paper was prepared to assist in understanding what
future developments are to occur and how it is to be accomplished.

in the United States.

Paleogeography.--The Chattanooga shale and its correlatives accumulated in a widespread interior sea covering vast areas of North America. The sea lay west of the ancient landmass of Appalachia and was apparently bounded on the south and southwest by the landmasses of Ozarkia and Llanoria. Configurations of its shorelines and the positions of probable island and shoal areas are mostly unknown. The Nashville dome in Tennessee and the Jessamine dome in Kentucky apparently were persistently high areas in the interior sea. In general the shale is thinner in Tennessee and thicker to the north and northeast. Some of the difference in thickness probably reflects the distance from a land area which supplied the sediment, although locally it results from the fact that some areas received no sediments at certain times, probably because they were out of water.

Structure.--On the east and west flanks of the Nashville and Jessamine domes the Chattanooga and equivalent formations dip away from the crest at low angles. Westward the shale strata disappear under the Eastern Interior Coal Basin in Indiana and Illinois. East of the Nashville dome the shale underlies much of the Eastern Highland Rim Plateau and the Cumberland Plateau at depths of 300 to 2,000 feet. It is essentially flat-lying in this area but is warped locally into numerous gentle folds. In the folded area of eastern Tennessee, the shale is exposed as long parallel bands and dips at moderate to steep angles. In Alabama the Chattanooga is largely concealed by younger strata but is exposed along lines of folds in the northeast

part of the State.

Paleontology.--In addition to abundant plant remains, marine organisms of Upper Devonian age include Lingula-like brachiopods, conodonts, and a few fish remains. Conodonts are microscopic plate-like or toothlike parts of an undetermined type of animal, are of great diversity, and have proved to be good stratigraphic markers (Conant, 1949, p. 7).

Stratigraphy.--The Chattanooga formation in east-central Tennessee is about 35 feet thick and consists chiefly of alternating beds of shale and gray claystone or siltstone. The black shale beds are nearly massive when fresh but are fissile when weathered. The different beds are practically identical in appearance, though they can be differentiated in part by their conodonts.

A layer of fine- to coarse-grained sandstone, commonly an inch or less thick, is present at the base of the Chattanooga at most places. It contains assorted conodonts and scattered fragments of shells and bones.

A conspicuous gray siltstone zone in the middle and lower part of the section in east-central Tennessee is as much as 9 feet thick in places but is absent near the north and south borders of the State. It consists of interbedded black shale and medium-gray siltstone or claystone, the gray beds predominating. A thin bed of bentonite, about one-half inch to 2 inches thick, is a good stratigraphic marker in this area (Hass, 1948, p. 616) and is everywhere within 2 feet of the top of the siltstone zone.

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in their behavior. Such findings of possible non-psychotropic
compounds with similar effects are interesting, yet the results
of this research are inconclusive. Further research is needed to
try to confirm the possibility of other compounds having similar
effects. However, it is clear that there are significant differences
between the effects of the two substances.

(V. M. T. 1971, unpubl.)

Secondly, it is important to understand what determines
the ability of individuals to produce maximum performance under
such conditions. One factor is the individual's own choice
of the activity, because most subjects are more interested in chess
and less interested in running or swimming than in other sports.
This factor need not play a large role here, since it is
not the "natural" characteristics of each individual

which are important but the social role of society which has
so strongly influenced the typical behavior patterns of people

in our culture.

The second factor which may be important is the individual's
beliefs about his place in the community. If he believes that
he needs to be successful in his work and does not feel that he can do
an acceptable job, he will make up his self-esteem by doing well at
what he believes to be just a "hobby" and avoid competing
against others. Thus, a person who feels that his place in society
is not recognized at all (as in, e.g., small towns without urban
amenities) will be less likely to succeed in chess.

Phosphate nodules, 1 to 12 inches in diameter, are abundant near the top of the Chattanooga in the northern part of Tennessee.

Composition.--The bituminous shale zones are composed of minute grains of quartz, clay, and organic matter. Pyrite and marcasite are distributed unevenly through the shale as small crystals, as crystalline aggregates in thin layers along bedding planes, or locally as nodules. The organic material, probably chiefly plant spores and plankton, constitutes approximately 16 percent of the shale and is disseminated through the rock. The rock yields about 9.5 gallons of oil per short ton (Battaille, 1949, p. 95).

Radioactivity.--The bituminous shale and gray siltstone units in Tennessee are relatively persistent and uniform, and the radioactivity is relatively uniform in any given part of the formation throughout a considerable area.

The uranium content of the Chattanooga shale ranges from 0.001 to 0.035 percent. The higher figure was obtained from a sample of an almost pure bitumen vein in the shale which was collected by J. M. Nelson of the U. S. Geological Survey.

Normally the maximum content of uranium appears to be in the uppermost part of the formation, although nearly as much is present in the next lower bituminous shale zone (see fig. 2). The average uranium content of samples from east-central Tennessee is probably about as tabulated below (Conant, 1949, p. 8).

the Society for the History of the American Revolution
and the American Revolution, the Society's annual meeting to be held at the
University of Southern Indiana beside Louisville, KY—will be held
on Saturday, June 27th, 1970.

Differences to be sought shall be those of historical opinion between the
American Revolutionaries, English colonists, and Americans
of the time of the Revolution, and between the American Revolutionaries
themselves as they evolved to maturity in their political positions
from the time of the American Revolution to the present day.

(See p. 1700, following)

After concluding the work of the Society members will be invited to

participate in a luncheon for interested scholars and historians
of all nationalities and to share their own research interests in a
seminar which will be held in the afternoon.

100,000 copies of the Society's annual publication, "The American Revolution,"

are available at \$1.00. Send checks or money orders to the Society, 2000 N.

W. 12th Street, Indianapolis, Indiana 46207. It is the position

of the Society to encourage the study of American history and to promote

scholarship at all levels of education, and to assist historians

concerned with the American Revolution in their professional development.

The Society's annual meeting will be held at the University of Southern Indiana

(c/o Hotel Indiana) located approximately one-half mile

<u>Name</u>	<u>Approximate thickness (feet)</u>	<u>Average ura- nium content (percent)</u>
Muddy shale	2	0.002*
Chattanooga shale		
Uppermost black shale	7	0.008
Upper silty zone	2	0.005
Middle black shale zone	8	0.007*
Main gray claystone zone	7	0.003*
Lowermost black shale	7	0.004*

* Estimated average, not actually calculated.

The radioactive elements in the Chattanooga shale belong to the uranium, thorium, and potassium families. No uranium mineral has been identified as yet, but the uranium is believed to be in an acid soluble form in the fine-grained or amorphous fraction of the rock (McElvey and Nelson).

It has also been suggested that clays may have withdrawn the uranium from sea water by a base-exchange mechanism (Frederickson, 1948, pp. 124-125) or by adsorption (Hoogtegling and Sisco, 1948, pp. 357-360).

Early studies of the Chattanooga shale indicated a marked relationship between radioactivity and organic content, thereby suggesting that marine plants may have withdrawn uranium from seawater and concentrated it in their tissues before their death and subsequent preservation in sea-bottom muds.

Analysis of a small sample of highly pyritic Chattanooga shale showed a higher uranium content than that of other shale samples from the same vicinity (Cartide and Carton, 1949, pp. 5, 12). Although the uranium is not contained in the pyrite or marcasite, a definite though not invariable relationship between the uranium and

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and the editor,
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and 20 individuals representing 10 different species of small plants and

and continue until you reach the bottom of the page.

人行道上也装上了路灯，而且一排排的，显得非常整齐，非常有秩序。

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more than 100000 individuals, which represents about 70% of today's population.

¹⁰ See *James Madison's Defense of the Constitution*, trans. by J. C. L. Lacour-Gayet (Paris, 1887).

¹ See also the discussion of the relationship between the two in the section on "Theoretical Implications."

Worship can now be viewed as a method "according to him" of "being in touch with God".

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Table 2. The effect of the number of nodes and the number of hidden layers on the performance

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第十一章 现代汉语词典(第5版)·现代汉语词典(第6版)

Consideration

<u>Name</u>	<u>Approximate thickness (feet)</u>	<u>Average uranium content (percent)</u>
Murry shale	2	0.002*
Chattanooga shale		
Uppermost black shale	7	0.008
Upper silty zone	2	0.005
Middle black shale zone	8	0.007*
Main gray claystone zone	7	0.003*
Lowermost black shale	7	0.004*

* Estimated average, not actually calculated.

The radioactive elements in the Chattanooga shale belong to the uranium, thorium, and potassium families. No uranium mineral has been identified as yet, but the uranium is believed to be in an acid soluble form in the fine-grained or amorphous fraction of the rock (McElvey and Nelson).

It has also been suggested that clays may have withdrawn the uranium from sea water by a base-exchange mechanism (Frederickson, 1948, pp. 184-185) or by adsorption (Hoogteijling and Sisco, 1948, pp. 357-360).

Early studies of the Chattanooga shale indicated a marked relationship between radioactivity and organic content, thereby suggesting that marine plants may have withdrawn uranium from seawater and concentrated it in their tissues before their death and subsequent preservation in sea-bottom muds.

Analysis of a small sample of highly pyritic Chattanooga shale showed a higher uranium content than that of other shale samples from the same vicinity (Garde and Garber, 1949, pp. 5, 12). Although the uranium is not contained in the pyrite or marcasite, a definite though not invariable relationship between the uranium and

Leucostoma *caeruleum* *var.* *caeruleum*

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WILSON-1922
SILVER BIRCH
EDGES, AND THE
LEAVES ARE
SMOOTH, AND
THE MARGIN IS
ALMOST SMOOTH.

sulphides has been noted, the ratio of uranium to sulfur in analyses of samples from 25 widely scattered localities being on the order of 1:800.

Oil shales correlative with the Chattanooga

Several oil shales in the eastern and middle western parts of the United States (fig. 1) of Upper Devonian and lower Mississippian age are correlated in part with the Chattanooga formation, although the exact correlations with the various units of the Chattanooga shale are still uncertain. Most of these shales appear to be less radioactive than the Chattanooga of Tennessee. This may be due to one or more of the following factors:

- (1) The other formations may be similar to the less radioactive parts of the Chattanooga shale.
- (2) The other shales may include more elastic material or carbonates, both of which are noticeably absent from shales possessing abnormal radioactivity. The presence of calcium in the New Albany shale may account for its relatively low radioactivity.
- (3) The shale may have accumulated more rapidly, thereby diluting the uranium precipitates, whatever their nature.

New Albany shale.--The New Albany shale occurs on the west flank of the Cincinnati arch in Indiana and north-central Kentucky. The formation ranges in thickness from 50 to 140 feet and, in general, resembles the Chattanooga shale. Pyrite is well distributed throughout the New Albany. According to Reeves (1922, p. 1070) and Campbell (1946,

and during normal operation. The system can identify and evaluate
the value over the system "life cycle".

System 100 will also provide information required to
determine whether existing and future use exceeds the
maximum acceptable level of the system. System 100 will
make this information available with other forms of information now and
available with the current computer and information systems. Data and
information on current usage must be gathered from various sources
and areas of the power plant. These areas include the control room, the
operator's station, the maintenance department, and the production
area. Information on the system will be provided to the
operator by the system operator or the maintenance manager. (5)

System 100 will also provide information to the system manager
and the system operator concerning the potential effects on
existing equipment and structures. This information may
be provided to management, engineering, operations, maintenance,
and planning personnel. System 100 will also provide information
concerning the potential effects on the system.

System 100 will also provide information to the system manager
and the system operator concerning the potential effects on the
existing equipment and structures. This information may be provided
to management, engineering, operations, maintenance, and planning
personnel. System 100 will also provide information to the system
operator concerning the potential effects on the system.

p. 875), lime concretions are abundant, and Campbell also mentions the presence of sandstone and limestone lenses in the bulk of the shale. The topmost part of the New Albany shale contains phosphatic nodules. This formation in Indiana yields from 6 to 14 gallons of oil per ton of rock.

The data available at present suggest that the New Albany in Indiana is less radioactive than its equivalent in Tennessee and Kentucky but is more radioactive than correlative in Ohio, Illinois, and Missouri. Parts of the New Albany contain about 0.006 percent uranium (Nelson and Stratton, 1949, pp. 7-8). The relatively high calcium carbonate content of this formation may explain the weaker radioactivity of the New Albany shale compared with the Chattanooga of east-central Tennessee.

Antrim shale.--The Antrim shale of the Lower Peninsula of Michigan is considered to be of early Upper Devonian age (Cooper, 1942, p. 1745). It is similar to part of the Chattanooga shales, and marcasite nodules occur in some layers. According to available data, the Antrim is less radioactive than the topmost unit of the Chattanooga of Tennessee or of the New Albany formation (Slaughter and Clabough, 1944, Secs. 8-113 and 114; Beers, 1945, pp. 10-12).

Woodford shale.--The bituminous shale in the Woodford chert, which is widespread in Oklahoma and Kansas, has been doubtfully assigned to the Devonian and is considered by Gott (1948, p. 6) to be of late Devonian or early Mississippian age and possibly may be

providing such technical assistance and information as will assist in the use of such well oil wells, so as to avoid the necessity of removing such sedimentary strata which may not be fully broken out, and in making it be a more easily worked oil reservoir after extraction.

to students aged 11 and 12 years old, who were asked to draw a picture of what they thought would be the best way to help people with autism. The drawings were then analysed by two researchers who had no prior knowledge of autism. The drawings were then analysed by two researchers who had no prior knowledge of autism. The drawings were then analysed by two researchers who had no prior knowledge of autism.

Widely used half-pint milk containers are becoming increasingly popular, especially among young children who are often given such containers as rewards for good behavior.

correlated with the Chattanooga. It ranges in thickness from less than 20 to more than 400 feet. Alternating beds of chert and dark fissile shale are the chief constituents, and dark gray to black nodules are abundant locally in the shale or along partings between shales and chert. The beds yield shale oil, and tests show that they are consistently higher in radioactivity than other formations in Oklahoma. They contain an average of 0.007 percent uranium and range from 0.003 to 0.010 percent (Slaughter and Clebaugh, 1945, pp. 11-12). The most radioactive parts of the formation seem to be marginal to the deeper parts of depositional basins, as shown by deflection in gamma-ray logs of drill holes (Gott, 1945, p. 7).

Miscellaneous oil shales equivalent in whole or in part to the Chattanooga.--The formations listed below are similar to the Chattanooga in general characteristics, but where they have been examined their radioactivity is relatively low.

<u>Formation</u>	<u>State</u>
Cleveland shale	Ohio
Surbury shale	Ohio, Kentucky
Ohio shale	Ohio, Kentucky
Genesee shale	New York
Dunkirk shale	New York

CARBONACEOUS SHALES

In this group are included the carbonaceous or "black" shales that do not yield oil on distillation but contain abundant carbonized plant matter, chiefly land plants. Some of the most favorable carbonaceous shales that have been examined for radioactivity are discussed

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NOTES

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DEFINITIONS

Acquisition	Refers to the process of purchasing another company or business unit.
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REGULATORY REQUIREMENTS

Regulatory requirements may be imposed on the Company by law or regulation, which may affect the Company's business and operations and on the basis of which the Company may be required to make certain changes to its business practices, products, and/or services. The Company will comply with all applicable laws and regulations, and will take all necessary steps to ensure that it remains in compliance with such laws and regulations.

briefly here.

Pennsylvanian black shales

Erin shale

The Erin shale, which is probably of early Pennsylvanian age, occurs in Clay County, eastern Alabama. It is a black pyrite-bearing shale or slate which weathers to a gray color. Tests throughout a stratigraphic thickness of 510 feet indicate that in most of the formation the radioactivity is no more than the average for sedimentary rocks, although samples from a relatively rich zone, 3.5 feet thick, contain 0.009 percent uranium (Butler and Chastain, 1945, pp. 21-22). No relation can be discerned between the more radioactive part of the formation and any other recognizable feature that might explain localization of radioactivity.

Pennsylvanian shales of Oklahoma and Kansas

Radioactive carbonaceous shales of Pennsylvanian age are present at the surface in northeastern Oklahoma and southeastern Kansas and occur at considerable depth along the buried Neosho anticline and on the northeast flank of the Wichita Mountains. The shale beds in this area range from 0.2 to more than 12 feet, averaging 3 feet, in thickness. The thin beds of black fissile shale are separated by limestone strata and are commonly underlain by thin coal beds. The general character and considerable stratigraphic range of the shales are shown in figure 3.

Small phosphatic nodules and concretions are abundant in many of the shale beds. The nodules are fine-grained, hard, usually black

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the defendant, with the addition of the word "not" after "not".
Secondly, there would be no "immediate" reference to the accused
in this case since the term of "immediate" refers to such
action as may be required by law to prevent the continuation
and/or increase of the offense. The word "not" is not used
here to mean that the accused must be given time to think.
It is used here to mean that the accused must be given time
to consider his defense. The word "not" is used here to mean
that the accused must be given time to think.

www.scholarlypublications.com

Final offshoots of the main stem are numerous, each bearing a few

or brown, and locally contain pyrite or marcasite. Some nodules are nearly round with a maximum diameter of two inches; others are flat and irregular in shape with a maximum diameter of three inches. Their occurrence in the shale is erratic, and their radioactivity varies. The nodules are commonly more radioactive than the surrounding shale (Slaughter and Clabaugh, 1945, p. 16). The carbonaceous shale over the Checkerboard limestones in the Coffeyville formation of Oklahoma appears to be the most favorable for abundance and radioactivity of nodules. At one locality in Tulsa County, the shale is estimated to contain about five percent nodules; the average uranium content by chemical analysis of the nodules is 0.030 percent, but the average for 5.7 feet of the shale is about 0.003 percent (Slaughter and Clabaugh, 1945, p. 17) (see fig. 4). Radioactive black shales and phosphate nodules have not been studied in sufficient detail to determine why the nodules are much more radioactive than the shale. It is apparent, however, that phosphate has an affinity for uranium in this environment similar to the affinity found in phosphate deposits.

The light-colored clayey shale and adjacent coal have a very small uranium content.

Recent studies of gamma-ray well logs suggest that abnormally radioactive zones occur above fault planes and along ancient erosion surfaces in this area (Gott, 1948, p. 17). Whether or not concentration of radioactive material is genetically related to faulting or to deposition following erosion intervals has not been determined.

the station was connected to power stations along the river. Finally the electric power and hydroelectric stations have been built around cities so people can have a lot more electrical power. Hydroelectric power plants are often a good way to generate clean and important and fast electricity production and because it's zero-waste generation will also be good because no waste is created. In addition, hydroelectric power plants are renewable and so there is less chance that there will be energy problems in the future. After the hydroelectric power plant is built, it will help reduce water usage and reduce energy waste which can help to save money and to protect freshwater resources. This is because hydroelectric power plants are built near rivers and lakes which are used for irrigation, drinking, and other purposes. This is good for the environment because it helps to reduce water usage and to protect freshwater resources.

Now I will show you how the power system works. First, there is a hydroelectric power plant which is located in a river or lake. The water from the river or lake flows through a pipe into the power plant. Inside the power plant, the water passes through a turbine which rotates a generator. The generator produces electricity which is then sent to a transformer. The transformer increases the voltage of the electricity so it can be transmitted over long distances. Finally, the electricity is sent to homes and businesses where it is used for various purposes such as lighting, heating, and cooling. This is how the power system works.

The results of radioactivity tests of other Pennsylvanian black shales are given in the following table.

<u>Formation</u>	<u>State</u>	<u>Percent uranium</u>	
		<u>Shale</u>	<u>Nodules</u>
Bandera	Oklahoma	low	.016
Bourbon	Kansas	.013	.032
Fort Scott	Kansas	.005	.017
Hushpuckney	Kansas	.010	
Lebette	Oklahoma	low	.022
Stark	Kansas	.008	.021

- - - -

Upper Triassic

A radioactive shale of Upper Triassic age was recently discovered in the Lockatong formation in New Jersey (fig. 1). The Lockatong is the middle formation of the Newark group, which is exposed in a broad band extending northeasterly across the central part of the State. The Lockatong formation ranges in thickness from 1700 to approximately 2600 feet and consists of carbonaceous shales, dark-red shales, hard massive argillite, and a few thin layers of calcareous shales. Pyrite is abundant in some of the massive dark shales.

Samples collected at Woodsville, New Jersey, east of Sourland Mountain, include one containing 0.016 percent uranium. The samples obtained probably come from the middle part of the formation, although considerable faulting and soil cover make the stratigraphic position difficult to determine.

should not be limited to those mentioned in the following list.
Additional publications may be added after consultation

Author	Title	Editor	Editorial
10.		1960	1960
20.	720.	1960	1960
30.	800.	1960	1960
40.	900.	1960	1960
50.	1000.	1960	1960
60.	1100.	1960	1960
70.	1200.	1960	1960

- - - - -

APPENDIX E

background literature has been divided into three categories:
1) general off site with regard to potential migration and
ability of response at radio doses ranging up to 100 milliroentgen/hour and
2) data off site in the Letting and Health Radiation Protection Committee's
classifications of Dose and Dose Rate in Nuclear Power Plants in relation with
heat generation and the resulting temperature rise due to heat
dissipation, radiation exposure to external sites and a third category of
radiation field which may be used in simulation of
radiation to have external field with respect to distribution, dose
and time and radiation damage due to radiation from nuclear fission
processes or to other nuclear processes involving fission products
and fission fragments and their decay products from artificial production
and release of fission products.

Upper Greenhorn

Two small lenses of ferruginous carbonaceous shale in the upper ^{Upper Greenhorn} Belkota sandstone in Turkey Creek Canyon, Morrison-Weldon Area, Colorado, were examined. Two samples from these lenses contain 0.008 and 0.035 percent uranium, respectively (Berndt, Granger, and Sharp).

SLIGHTLY LUMINESCENT SHALESPhosphoria oil shales

The Phosphoria oil shales of Permian age in Idaho, Montana, and Wyoming are marine sediments which are of interest for their phosphate content and abnormal radioactivity. For a detailed description of this formation, see the chapter titled "Relation of uranium and phosphate in the Phosphoria formation."

Green River oil shales

The Green River formation ofocene age is widely distributed in parts of Colorado, Utah, and Wyoming (Fig. 1). It consists of alternating beds of oil shales, siltstone, and, locally, limestone. The Green River shale differs from the oil shales described above in that it is of lacustrine rather than marine origin, and calcite is the predominant mineral constituent (Bradley, 1925, pp. 121-131). The organic content is as much as 36 percent, which is more than that of the Chittenango.

The members of the Green River formation are, in ascending order:

- Karow Creek
- Landy shale
- Tipton tongue
- Young sandstone lentil

REVIEWERS' COMMENTS

The author has done an excellent job of presenting the results of his research. He has clearly defined the problem and has provided a detailed description of the methodology used. The results are presented in a clear and concise manner, and the conclusions drawn from the data are well supported by the evidence. The overall quality of the paper is high.

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The Laney shale is the principal oil-bearing member occurring in the Green River and Uinta Basins and includes a black shale that weathers to a conspicuous bluish white and a light- to dark-brown shale that weathers buff. The bituminous shale, containing 19 percent organic matter, yields about 35 gallons of oil per short ton (Battaille, 1949, p. 93). Part of the Tipton tongue is a low-grade peary oil shale with a yield of less than 10 gallons per ton. The few tests that have been made of the Green River oil shale at the outcrop show that the radioactivity of the formation is about normal for sedimentary rocks (Chesterman and Main, 1947, pp. 14-15). Radioactivity measurements made in the Geological Survey laboratory on samples from the Bureau of Mines Experimental Mine at Rifle, Colorado, show that the equivalent uranium content ranges from less than 0.001 to 0.003 percent and confirm the outcrop tests. This formation is, therefore, unfavorable as a source of uranium.

Modelo oil shale

The Modelo formation of middle Miocene age occurs in Los Angeles and Ventura Counties, California (fig. 1). The lower Modelo consists of bituminous and siliceous organic shales, and an oolitic phosphate bed occurs near its base in the Santa Monica Mountains. At points where it has been tested at the surface, this oil shale is low in radioactivity (Chesterman and Main, 1947, p. 16).

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problems that can threaten our national security or political stability
abstain from voting until we've sorted them out, and then go back to
voting again. I believe that the right to choose yourself is one of mankind's basic
rights. So, rather than avoid participating in the vote, which would have
all the people who care, including me, feeling angry and upset,

SUMMARY

The known radioactive black shales of the United States possess several characteristics that may serve as guides in finding other radioactive black shales. These characteristics are reviewed briefly below.

Thin-bedded fine-grained black shales of marine origin, including many oil shales, are commonly more radioactive than thick-bedded coarser rocks. Black shales of continental origin, such as the Green River oil shales, are not abnormally radioactive, whereas marine black shales that are products of slow deposition over long periods of time generally contain significant amounts of radioactive elements. The radioactive content is apparently related to the paleogeography, as it is highest in areas which received only small amounts of clastic debris from the land. In some formations the most radioactive parts seem to be marginal to the deeper parts of the depositional basins (Scott, 1948, p. 7), as illustrated by the Woodford.

The uranium content of carbonaceous and bituminous shales is not clearly related to the organic content. Coal, for example, is highly carbonaceous but rarely exhibits abnormal radioactivity. However, lignite with relatively high uranium content has recently been discovered in the Eocene Sentinel Butte (?) formation of North Dakota.

The oil yield of shales, which is proportional to the organic content, is not proportional to the radioactive elements. Although uranium is not found in the sulfide minerals of the carbonaceous or

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bituminous shales, it is present in the Chattanooga shale in an almost direct ratio to the sulphur, a ratio of about 1:800.

• 1980s we can see the movement towards a more pluralistic approach
• 2000s trends "to reflect a particularism with some global themes"

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REINHOLDER

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